

Research Newsletter

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A MESSAGE FROM THE RESEARCH DIRECTOR

By: Cameron Kergaye, PhD, PMP, PE

This summer the Research Division is starting work on 23 new projects that have been approved as a result of our workshop in March. Technical Advisory Committees have been formed and meetings with most Principal Investigators have been scheduled. We are working hard to meet academic schedules for those research contracts that utilize the talents and focus areas of graduate students. Our goal this year was to initiate all new projects in July, and so far we are on track.



March 2015 Research Workshop

One of the quickly moving new projects is Evaluation of Wrong-Way Driving Detection. Wrong-way driving occurs when a vehicle moves against traffic, often at high speeds on divided highways. Although the occurrence is infrequent compared to other safety incidences, we are beginning to see national research into causes and countermeasures. Our research project will conduct an all-states survey and possible field investigation of active avoidance technology. A report of findings is scheduled to converge at the end of the year to sup-

port a WWD detection initiative by UDOT's Traffic Management Division.

Wrong way driving will also be one of our suggested topics for the US Domestic Scan Program. This AASHTO initiative, with funding and oversight by NCHRP, provides funding and support for a broad and intensive investigation of innovative technologies. It enables state DOT and other experts the opportunity to view and learn about solutions to specific transportation challenges. Proposed topics must be submitted to AASHTO by October 15. UDOT's proposal on Knowledge Management was accepted in 2012 and led to the [scan team report on Scan 12-04](#).

October 15 is also the due date for NCHRP's general research program solicitation, which represents about \$35 million for new and continuing research projects. Last year UDOT assisted with submitting 11 problem statements, five of which were recently funded. Projects typically receive \$200-500k of funding and are awarded through NCHRP's procurement process. This has been one of the effective ways for state DOTs to fund and accomplish research that is of interest nationwide.

Finally, UDOT recently applied for FHWA implementation assistance for two SHRP2 products: 'Identifying and Managing Utility Conflicts', and 'PlanWorks: Better planning Better projects'. We previously applied for 14 implementation products, and have been awarded nine. So I would like to acknowledge the hard work of those involved in the application process, and the continuing work of those working on product implementation. The final round of SHRP2 product implementation assistance will be advertised early next year.

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Completed and Active Research Available at: www.udot.utah.gov/go/research

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Results of the 2015 Research Workshop (UTRAC)

Projects have been selected for FY16 funding from the 2015 UDOT Research Workshop held on March 24th.

Fifty-seven problem statements were submitted this year for the UDOT Research Workshop. Of these, 23 will be funded as new research projects through the Research Division. Some submitted problem statements will be funded directly by other divisions.

The workshop serves as one step in the research project selection process which involves UDOT, FHWA, universities, and others. UDOT Research Division solicited problem statements for six subject areas: Materials & Pavements, Maintenance, Traffic Management & Safety, Structures & Geotechnical, Preconstruction, and Planning.



At the workshop, transportation professionals met to prioritize problem statements in order to select the ones most suitable to become research projects.

After the workshop, UDOT Research Division staff reviewed prioritization and funding for each recommended problem statement with division and group leaders and presented the list of new projects to the UTRAC Council.

The selected new projects include:

- Performance Related Specifications for Asphalt Pavements Using BBR (U of U)
- Accuracy of In-Situ Water-to-Cement Meters for Concrete (U of U)
- Asphalt Mix Fatigue Testing using the SCB/AMPT -- Phase II (CMETG)
- Bridge Deck Concrete Surface Resistivity for Performance-Based Tests (USU)
- Safe Driving Limits for Snow Plow Operations (Time Limits) (UDOT)
- Plowable Pavement Markings under Wet-Night Road Conditions (UDOT)
- IT Infrastructure Preparedness Review (UDOT)
- Tools for Reducing Wildlife-Vehicle Collisions (UDOT)

- Hotspot and Sampling Analysis for Effective Maintenance Management and Performance Monitoring (UDOT/U of U)
- Analysis of Access Management Impacts in Utah (BYU)
- Evaluation of Wrong-Way Driving Detection (UDOT)
- Measuring Pedestrian and Cyclist Exposure and Risk in High-Risk Areas (Active Planning)
- Examining the Characteristics of Fatal Pedestrian Crashes (Active Planning)
- Simplified CPT Performance-Based Assessment of Liquefaction and Effects (BYU)
- Cyclic Lateral Resistance of Abutment Piles Near MSE Walls (BYU)
- 21st South Seismic Station Upgrades and Research Opportunities (UDOT/USU)
- Passive Force Development for Controlled Low-Strength Material (CLSM) Backfills (BYU)
- Decision Tree Development for Drainage Pipe Replacement, Relining, or Localized Repair (UDOT/USU)
- Testing New Technology Solutions to Restrict Wildlife Access to Highways (UDOT/USU)
- Reducing Project Delays Due to Utility Relocations (UDOT)
- Safety Index Forecast Model (RSG)
- Measuring Systemic Impacts of Bike Infrastructure Projects (Active Planning)
- Key Enhancements to the WFRC/MAG Four-Step Travel Demand Model (U of U)

John Njord, former UDOT Executive Director, gave an insightful keynote address on the future of transportation. Dr. Patricia C. Cramer, Research Assistant Professor with Utah State University, was presented with the UTRAC Trailblazer Award for her significant research contributions in the area of wildlife connectivity. Jason Richins was our workshop coordinator and did a great job.

We appreciate everyone's participation in the workshop process. The new research projects can start as early as July 2015 in coordination with UDOT Research staff and champions.

To see details on the new projects and all submitted problem statements, visit the [UDOT Research Division](http://www.udot.utah.gov/research) website. For more information contact David Stevens at davidstevens@utah.gov.

I-15 Express Lanes Study

The purpose of the Express Lanes Study conducted by Brigham Young University includes two phases of research: first to perform a system evaluation, and second to provide recommendations to maintain the performance of these lanes in Utah.



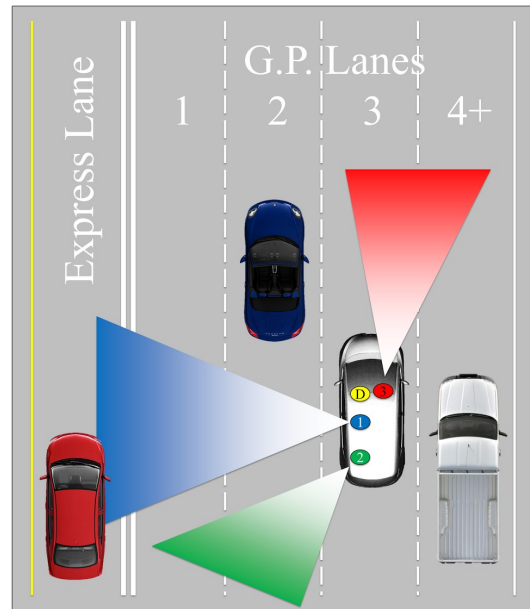
The primary objectives of the first phase of study included a literature review on how changing toll rates, occupancies, and violation rates have had an effect on Express Lane use (i.e. managed lanes or High-Occupancy Toll lanes) and an examination of the utilization of the I-15 Express Lanes under a limited number of congestion and pricing scenarios. The research analyzed the data for the Express Lane in Utah including an analysis of speed, volume, and toll rates using the UDOT Performance Measurement System (PeMS) and a detailed analysis of Express Pass transponder and registered Clean Vehicle presence within the Express Lane. The results of this first phase of study indicate that the majority of the Express Lane corridor in the state of Utah is operating within the 10th percentile speed goal of 55 mph set by UDOT and the 45 mph requirement set by the Federal Highway Administration. There are, however, some zones where 10th percentile speeds have dropped below 55 mph during that AM Peak or PM Peak, located along the South Salt Lake Valley. From these results, several countermeasures were identified that could reduce traffic volume in the Express Lanes, with the ultimate purpose to improve the speeds within the Express Lane. Additional research was needed to evaluate the effectiveness of the proposed countermeasures.

The primary objective of the second phase of study included an investigation of the vehicle types and vehicle occupancy of traffic on I-15 between Spanish Fork and North Salt Lake City and an evaluation of proposed countermeasures, based on observed traffic composition. The carousel method was implemented, which allowed the observation of General Purpose and Express Lane use while traveling with the flow of traffic along I-15. In addition to an empirical analysis of speed-volume relationships of these lanes, a literature review was

conducted regarding the impact of possible countermeasures to improve speed in the Express Lane. After 3,000 driven miles of observation, the Express Lanes were found to have an average traffic composition of 16% Single Occupant Vehicles (without authorization for Express Lane use), 68% Carpooling Vehicles (with 2+ occupants), 11% Express Pass users, 2% Registered Clean Vehicles, and 3% Other (including motorcycle, bus, and emergency vehicles). The overall average vehicle occupancy for the Express Lane is 1.90 people per vehicle (weighted average for all time periods and directions). The recommended countermeasures for improving speed in the Express Lane includes (1) increase the toll rate, (2) improve education and enforcement efforts to discourage unauthorized single occupant vehicles from lane use, and (3) allow additional registration tags for Clean Vehicles. Additional monitoring of Express Lane performance will be necessary to measure the

actual effectiveness of the implemented countermeasures, especially after the lane improvements at the Point of the Mountain and the installation of Express Lanes between Salt Lake City and Ogden.

The implementation of the carousel method in this study was accepted for paper and poster submission at the 2015 Transportation Research Board Conference in Washington D.C., where many transportation engineers from across the U.S.A. and outside of the country were interested in UDOT's efforts to manage the Express Lanes and optimize efficiency.



For additional details of the studies, see [UDOT Report 14.05 Schultz et al.](#), [UDOT Report 15.03 Schultz et al.](#), and [TRB Paper #15-1948 Schultz et al.](#) For further information, contact Grant Schultz of BYU (gschultz@byu.edu) or Kevin Nichol (knichol@utah.gov) of UDOT's Research Division.

Clearing Roads Through Collaboration

Clear Roads is a national research consortium focused on rigorous testing of winter maintenance materials, equipment and methods for use by highway maintenance crews. This is a Pooled Fund Project TPF-5(218), led by the Minnesota Department of Transportation.



UDOT has been a participating member and major contributor of Clear Roads since its inception in 2004. UDOT participates not only through its annual \$25,000 monetary contribution, but also by actively participating on the Technical Advisory Committee (TAC) which nominates, selects, and follows through on a wide variety of research initiatives related to winter maintenance. Through its active participation on the TAC, UDOT has facilitated research that has directly benefited UDOT. Some examples include:

- ⇒ The use of flexible plow blade systems such as the JOMA blade
- ⇒ Better calibration of automated spreader systems
- ⇒ Better adherence to recommended salt application rates
- ⇒ Increased use of technologies and methods such as pre-storm anti-icing with salt brine or other chemicals
- ⇒ Implementation of the Tow Plow

Over the years, Clear Roads has undertaken dozens of important, and very practical, research projects. Currently, research projects developed and funded by Clear Roads are underway for about a dozen exciting new topics. Some randomly picked highlights include:

- ◆ **12-04: Snowplow Operator and Supervisor Training.** This project will develop a series of flexible training modules for snowplow operators and supervisors that can be used, modified or updated by any of the Clear Roads member agencies.
- ◆ **12-06: Plug and Play Initiative.** Sensors and other devices used on DOT vehicles are often provided by different vendors, each with their own proprietary communication protocols and data formats. It is costly and time intensive to integrate the different systems into one data stream. The adoption of a standard protocol and specification would simplify the process of adding new components and reduce the overall costs to develop and maintain a mobile data platform.



- ◆ **13-01: Snow and Ice Control Environmental Best Management Practices Manual.** This project will develop a comprehensive Snow and Ice Control Environmental Best Management Practices (BMP) Manual that will provide the most up-to-date recommendations for winter highway maintenance. This resource will help articulate responsible snow and ice control practices for DOT staff, legislators and other interested parties, so that the priorities of safety, efficiency, cost and environmental protection can be appropriately balanced.
- ◆ **13-04: Best Practices for the Prevention of Corrosion to DOT Equipment: A User's Manual.** Corrosion to maintenance equipment resulting from the use of chloride deicers is a challenge for transportation agencies across North America. While there are many products and much anecdotal guidance for the prevention of corrosion, there is not a consolidated guide that combines all of the available knowledge on corrosion prevention for use by snow and ice control practitioners. The end result of this project will be an easy-to-use guide that summarizes in layman's terms the best practices to prevent corrosion to maintenance equipment.
- ◆ **14-01: Synthesis on GPS/AVL Equipment Used for Winter Maintenance.** Many states are interested in testing or implementing GPS/AVL systems to gather information on their winter maintenance programs, including truck location, truck speeds, material usage rates, etc. To help states better understand the options available (systems and components) for varying situations and truck configurations, this project will develop a clearinghouse of information based on state experiences with GPS/AVL.

Clearing Roads Through Collaboration (Cont.)



Although UDOT is a recipient of the many benefits of the Clear Roads activities, UDOT is not just a taker. UDOT is, and has for many years been, at the forefront of winter maintenance technology and innovation. UDOT therefore is proud to share its success, and its learning experiences, with the other member states. It's another way in which Utah is able to be a leader among state transportation agencies.

UDOT's representative on the Clear Roads TAC is Brandon Klenk in Maintenance Planning. Part of Brandon's role is to propose areas where new winter maintenance research may be needed. He can best do that with meaningful input from all

who work in winter maintenance at UDOT. So keep in touch with Brandon, and share with him your thoughts on where winter maintenance needs improvement or additional research. He can be reached at bklenk@utah.gov or (801) 965-4094. Who knows, one of your ideas may end up helping highway agencies all over the North American snow belt do something a little better, to the benefit of the millions of travelers they serve.

For more information on the Clear Roads initiative and Pooled Fund Project, visit their website at www.clearroads.org. Lloyd Neeley in Maintenance Planning can also be contacted for more information at lneeley@utah.gov.

Wyoming Wildlife Crossing Scan Tour

On June 30, 2015, UDOT and Utah Division of Wildlife Resources staff met with Wyoming DOT and Wyoming Game and Fish staff to tour Wyoming's new wildlife crossings. The almost \$10 million project was substantially complete in October of 2012. The project constructed six underpasses and two overpasses and put in wildlife fence and escape ramps over a 12-mile section of US 189/191, west of Pinedale, Wyoming. US 189/191 crosses a large migration path of mule deer and pronghorn antelope. Over the past 20 years traffic in the area has increased and so have wildlife-vehicle collisions. In 2010, the state released this project to reduce collisions.



Since construction, there have been 85% fewer wildlife-vehicle collisions. Structures have been monitored to see their effectiveness. From October 1, 2012 through May 14, 2015, all structures combined have seen 85,220 crossings (74% mule deer and 26% pronghorn). Most pronghorn (80%) seem to prefer the overpass structures and most mule deer (90%) prefer the underpass crossings.



The overpasses are 150-foot wide structures with 8-foot high berms on each side to limit the animal's view of passing vehicles. The overpasses were made from precast concrete arches.



The underpass structures were 70 foot long, 43 foot wide simple spans made with weathering steel rolled I-beams.

The overpasses cost approximately \$1.7 million and the underpasses \$350,000 each. UDOT and UDWR came away with a list of lessons learned. We were also able to share some successes that we have had with reducing wildlife-vehicle collisions in Utah. A partnership was developed that will benefit both states.

For more information, contact Jason Richins of UDOT's Research Division (jrichins@utah.gov).

Correlation Between Friction Testing Devices in Utah

Because pavement friction is an important component to safe roads, UDOT personnel asked researchers at Brigham Young University and Raba Kistner Infrastructure to determine whether the frictional properties of aggregates used in asphalt surface treatments can be predicted and correlated to laboratory testing. Twelve pavement sections scheduled for resurfacing, ranging from 3 to 12 years old, were selected in Salt Lake, Sevier and Emery Counties consisting of Open Graded Surface Course (OGSC), Chip Seal and Stone Matrix Asphalt (SMA). Each site was then tested with five different surface friction measuring devices.



Friction testing devices at research site

Each pavement section was tested for frictional properties using the lock wheeled skid trailer, British Pendulum and Dynamic Friction Tester (DF-Tester). In addition, each pavement section was tested for pavement texture using the sand patch method and Circular Texture Meter (CT-Meter). During a twelve month period, each site was monitored three separate times.

Samples of the aggregates used in the road surfaces were also obtained and tested in the laboratory.

The DF-Tester and CT-Meter had not previously been used in Utah before. Through a loan program set up through the FHWA, the two devices were sent to Utah on a two month loan. A researcher from Penn State was flown in to provide a full day workshop to train on how to run the devices. All together, the training and equipment received and fully funded through the



DF-Tester underside, showing rubber slider pads

FHWA loan program represent over a \$100,000 value to UDOT.

The data collection portion of the research recently concluded in June and the preliminary analysis is underway. The purpose of this research is to compare field friction measurements to laboratory friction measurements and evaluate how well the correlation between the two can predict the observed results. The researchers hope to be able to develop a three-way correlation of measurements between the British Pendulum Tester (BPT) in the field, the BPT in the laboratory, and the lock-wheel skid trailer.



Measuring the surface friction with a British Pendulum Tester

Previous research suggests that a correlation exists between the skid trailer and the laboratory accelerated polish test. By adding a Utah based testing program to supplement and extend their earlier work, the researchers hope to produce statistically significant field and lab correlations. Recommendations will then be made for the use of this information to establish friction guidelines. Appropriate use of this information by pavement managers can, in time, have a major impact on reducing accidents affected by low friction.

For more information, please contact Aaron Smith (aaron.smith@rkci.com) of Raba Kistner Infrastructure or Tom Hales of UDOT's Research Division (tahales@utah.gov).

What's Shaking with Retaining Wall Research? TPF-5(276)

UDOT is pleased to participate in pooled fund study no. TPF-5(276), Full-Scale Shake Table Testing to Evaluate Seismic Performance of Reinforced Soil Walls, led by Washington State DOT, and heavily funded by CalTrans. The 4-year study is being conducted to evaluate the seismic performance of reinforced soil retaining walls (often called MSE or mechanically stabilized earth walls).

The shake table testing for the project is the most important (and costly) aspect of this research. Due to the large required size and expense of these shake table facilities, there are a limited number of them across the country and even the world. Accordingly, there have been a relatively low number of such tests performed on full-scale retaining walls. Thanks in part to the connections of CalTrans and the lead researcher, Dr. Patrick Fox, the design team was given access to one of the most advanced and second largest shake table facilities in the world, an outdoor 25-ft by 40-ft shake "table" called the LHPOST, operated by the University of California – San Diego (UCSD Tritons, not the Aztecs). The shake table allows simulation of large earthquake ground motions. [Note: This particular shake table is large enough that an actual building up to 7-stories in height can be test-shaken.]



LHPOST shake table at UC San Diego
(<http://nees.ucsd.edu/facilities/shake-table.shtml>)

Phase 1 of the study, which has now been completed, consisted of background research and numerical parametric modeling using different factors including soil friction angle and soil reinforcement spacing. Due to the time and expense of running such tests, the researchers felt (and the oversight committee agreed) it would be most judicious to revise the Phase 2 testing

program to run six reduced-scale (6-ft high) laboratory tests on the UCSD's smaller shake table (12 ft by 16 ft), and then use the results to design the most effective full-scale, outdoor shake table test at the UCSD facility. The test data from the six laboratory test configurations will be modeled and analyzed using FLAC-3D software, with FLAC-2D also used for comparison purposes. The results of this model will then be used to design and evaluate the large (full-scale) outdoor shake table test. The earthquake shaking used for the tests will be derived from actual earthquake shaking records from three different seismic events, with the 1994 M6.7 Northridge, California, earthquake being used as the baseline event.

The anticipated study completion date is mid- to late 2016. The results of the study are expected to provide valuable information regarding earthquake design and performance of reinforced soil retaining walls in higher seismic areas of the country, including Utah and the west coast.

UDOT's technical advisory committee member for this pooled fund study is Jim Higbee with the UDOT Geotechnical Division. Besides CalTrans, WSDOT and UDOT, other agencies participating in the study include Idaho Transportation Department and Mississippi DOT. For additional information, please contact Jim at jhigbee@utah.gov or visit the study web page at: <http://www.pooledfund.org/Details/Study/511>.

Quote Unquote

Many a false step was made by standing still.
—Fortune Cookie

Life is too short to be small.
—Benjamin Disraeli

I haven't failed; I've found 10,000 ways that don't work.
—Benjamin Franklin

Research Calendar of Events

LEADERSHIP BOOK DISCUSSION

The next leadership book discussion with Shane Marshall will be held on Tuesday, August 18 at 11:00 AM in the Njord Conference Room of the UDOT Complex for all interested UDOT employees. The intent of these discussions is to share valuable and insightful lessons that support UDOT's culture of innovation and improvement. This will be the final installment of the discussion on ***The Speed of Trust*** by Stephen M.R. Covey. It will cover the third wave through the end of the book. Contact Joni DeMille in the UDOT Library (jdemille@utah.gov) to borrow a print copy of the book. The presentation can be broadcast to any region office. Please contact Joni to request this in advance.

RESEARCH FUNDING OPPORTUNITIES (click online to see the full document)

NCHRP Highway IDEA Proposals, DUE on September 1, 2015

NCHRP FY 2017 Problem Statements, DUE on October 15, 2015

2016 US Domestic Scan Program Topic Proposals, DUE on October 15, 2015



WEBINARS (click online to see webinar details)

Title	Day/Date	Time
Accessing the SHRP 2 Safety Data: User Responsibilities and Access Procedures	Monday, July 27	12:00 PM -2:00 PM
Using Winter Severity Indices for Winter Maintenance Performance Management	Wednesday, July 29	12:00 PM – 1:30 PM
Transportation Revenue Forecasting in the States	Thursday, August 13	12:00 PM – 1:30 PM
Flexible Pavement Preservation – Research Results	Tuesday, August 18	12:00 PM – 1:30 PM
Innovative Intersections for Pedestrians and Bicycles	Wednesday, Aug 19	11:00 AM – 1:00 PM
Connected Vehicle Tracking to Improve Operational Efficiency	Wednesday, Aug 26	12:00 PM – 1:30 PM
Seismic Pushover Analysis Using AASHTO Guide Specifications for Load and Resistance Factor Design (LRFD) Seismic Bridge Design	Monday, August 31	11:00 AM – 1:00 PM
Develop Your Signature Voice	On Demand	On Demand
Managing Conflicts in Teams	On Demand	On Demand
Great Leaders Grow: The Four Keys to Becoming a Leader for Life	On Demand	On Demand